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Quantum Hall effect analogs in photonic crystals: "chiral" (unidirectional) edge modes as "one-way waveguides"[1] S. RAGHU, F.D.M. HALDANE, Princeton University — "Photonic crystals" constructed from non-reciprocal (Faraday) media with broken time-reversal symmetry can have topologically non-trivial photonic bands with non-zero "Chern invariants". In electronic systems, filling such bands produces an (integer) quantum Hall effect (QHE). While photonic (bosonic) bands cannot be "filled," other features of the QHE - "chiral edge states" - persist. We present an explicit example of a periodic array of dielectric rods parallel to the Faraday axis of their surrounding medium, with a band gap for photon propagation normal to the rods, and topologically-non-trivial 2D bands. We then examine a "domain wall" across which the Faraday axis reverses. As the inevitable consequence of topology, there are modes in the gap which are localized at this interface, and allow flow of electromagnetic energy **in one direction only**, making a "one-way waveguide" without counterprogating modes, so it is robust against elastic backscattering at bends (though not against absorbtion, unlike charge flow in the electronic analog). The "Berry curvature" introduced by Faraday materials leads to a new class of novel possibilities for "photonic band-structure engineering," with possible technological applications.

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